NOvA APD Cooling Water Update

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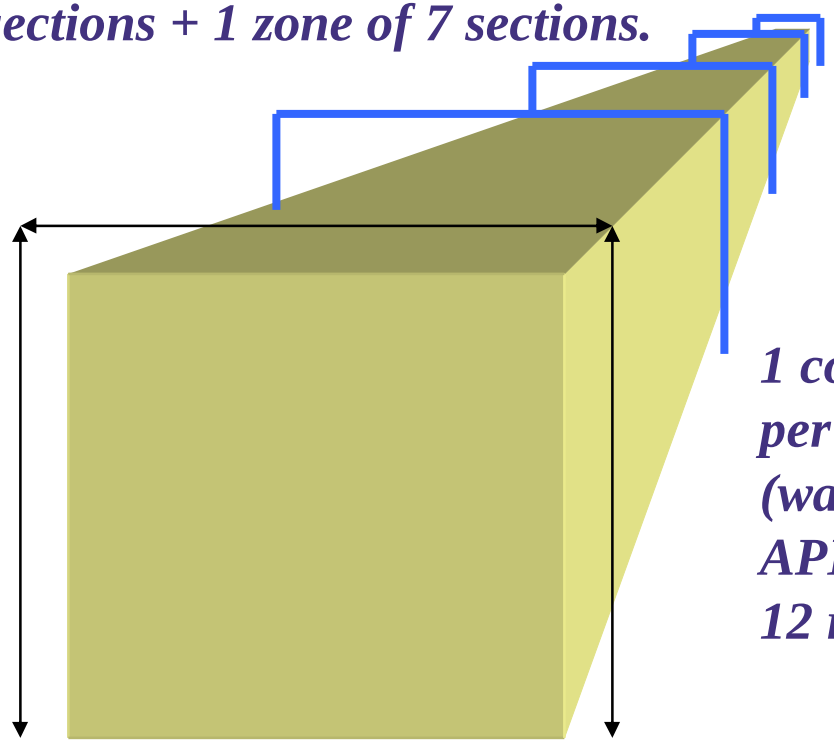
Cooling System Zones & Dimensions

4 cooling zones along the length of the detector supplied by chilled water at 48 ºF supplied by FESS.

- *3 zones of 8 sections + 1 zone of 7 sections.*

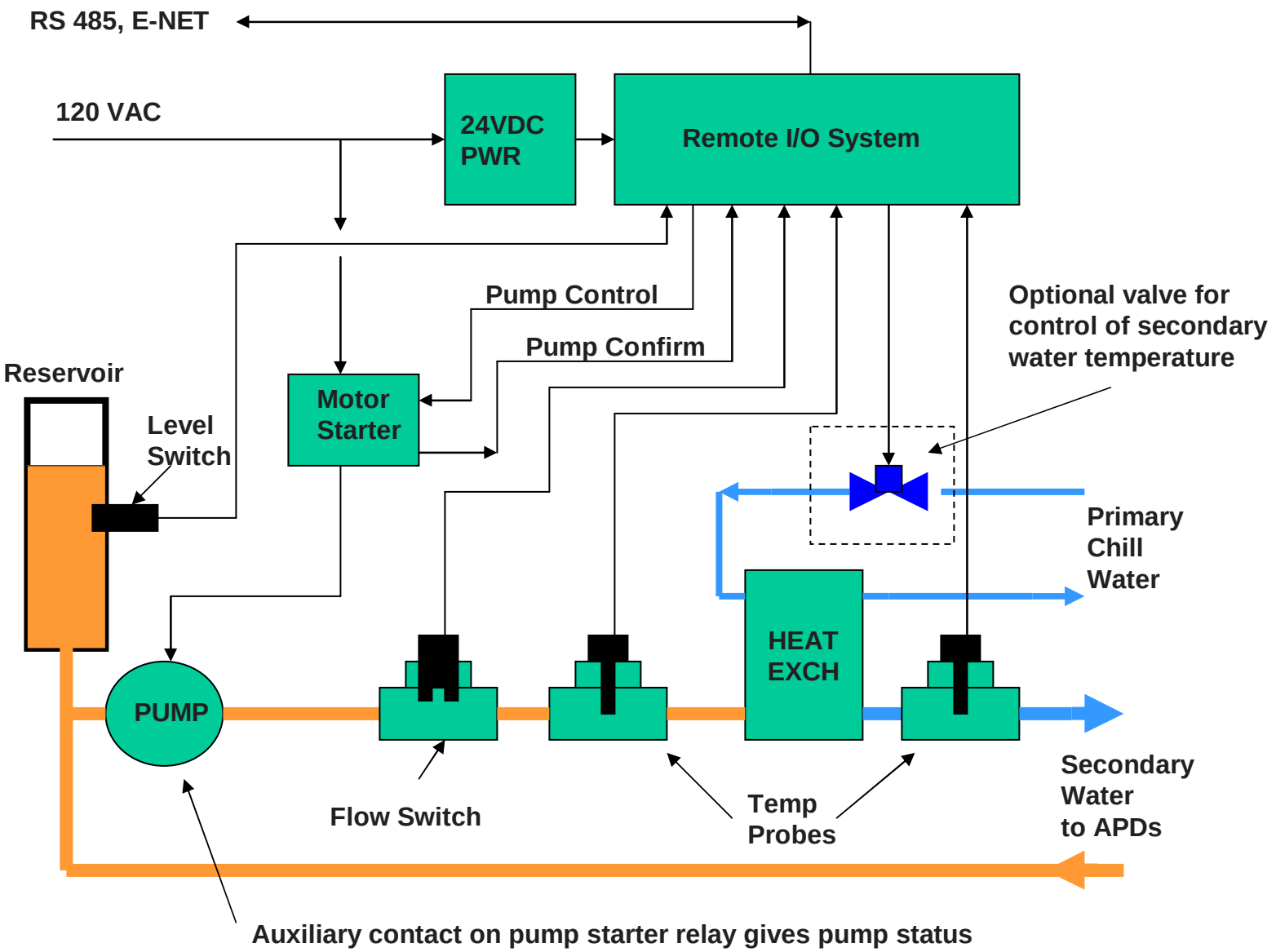


12 rows of detectors each face

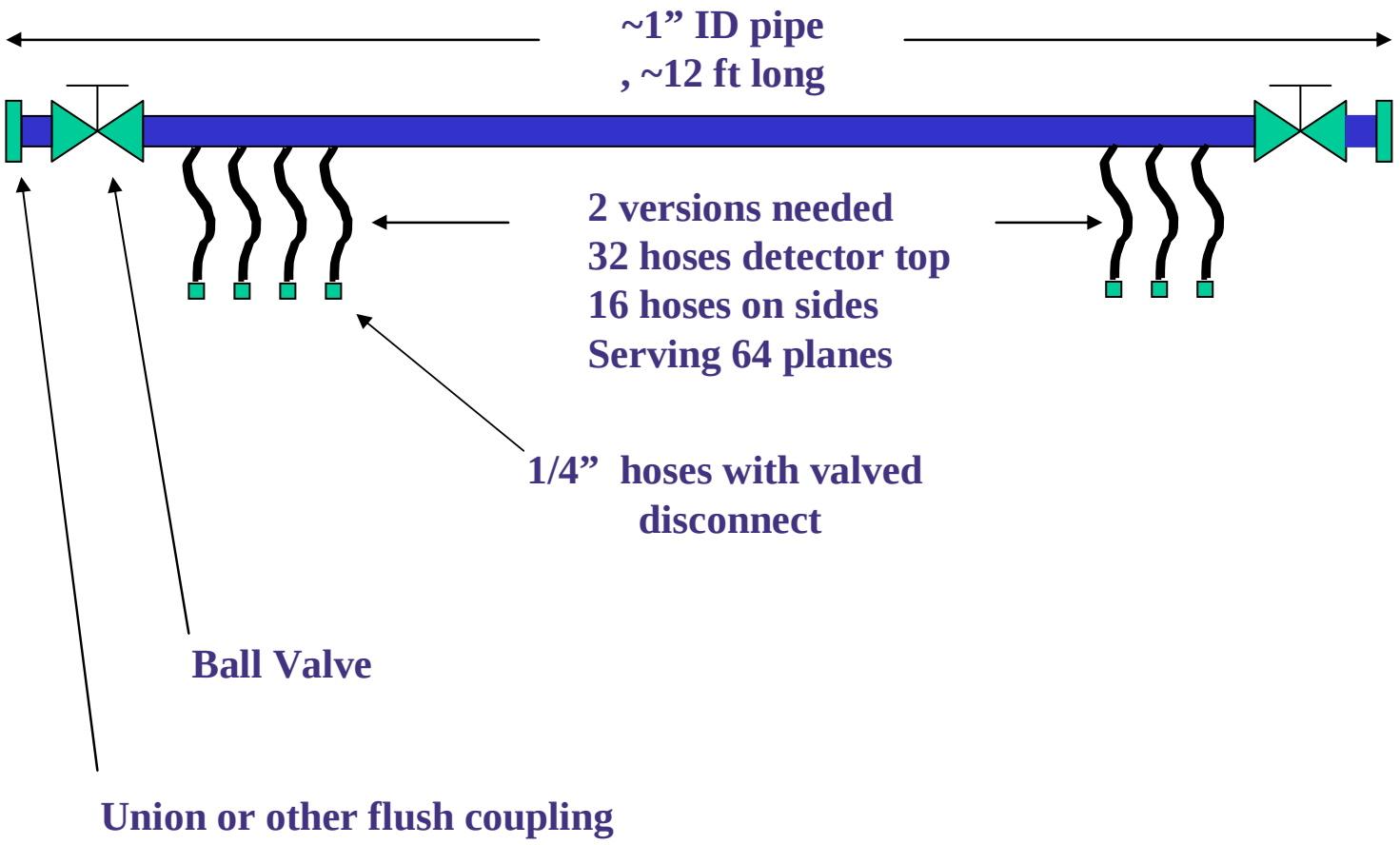
1 cooling loop per row, per zone, (water from heat exch to APDs)

12 row x 3 face x 4 zones = 144 secondary loops

Pump Unit & Instrumentation



NOVA Cooling Manifold Section



Single Loop Heat Calculations

5w per APD module x 217units = 1085w
Assume (guess) heat pickup in pipes, etc = 1085w
Total = 2170w

Loop delta T = Q(watts) / [263 x Flow(GPM)]
= 2170w / [263 x 6.87GPM]
= 1.2 degC

ITD = initial temp difference of fluids entering heat exchanger
= (APD water + del T) - FESS chilled water
= (15 degC + 1.2deg C) - 8.9 degC = 7.3 deg C

Q / ITD for this flow & load = 2170w / 7.3 degC = 297

Compare to high limit value from Lytron chart for this flow rate, 800
297 is much lower, so this is well within capacity of LL520!

Use Macroflow?

Innovative Research, Inc.
3025 Harbor Lane N, Suite 300
Plymouth, MN 55447, USA
Tel:(763) 519-0105

Macroflow example

Electronic cooling system via manifold distribution
30 elements X 4 rows, reverse return

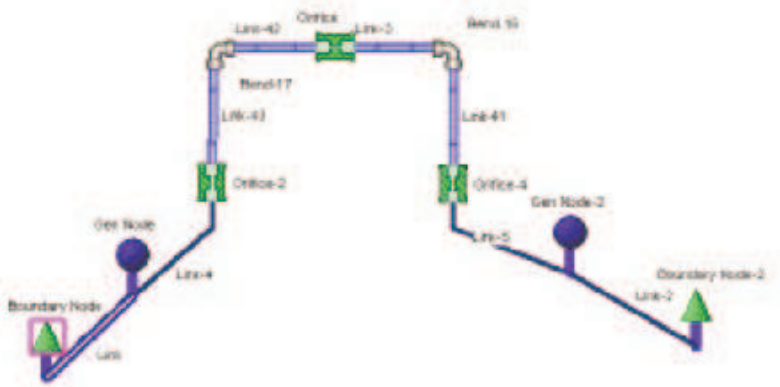


Figure 4. One Branch of the FNM, analogous to one LCM

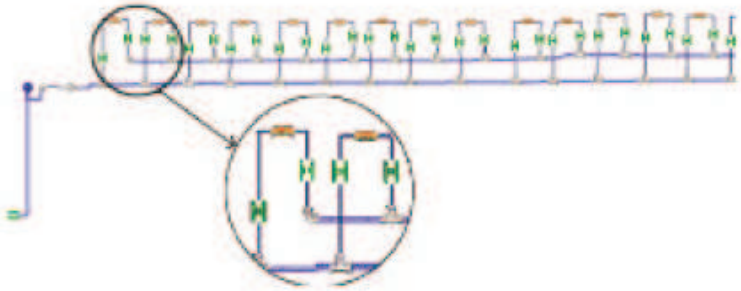


Figure 7. One Row of the FNM, analogous to a section of one row of the manifold

Complete System

The complete system consists of several rows of LCMs

Macroflow example part 2

Looks very similar

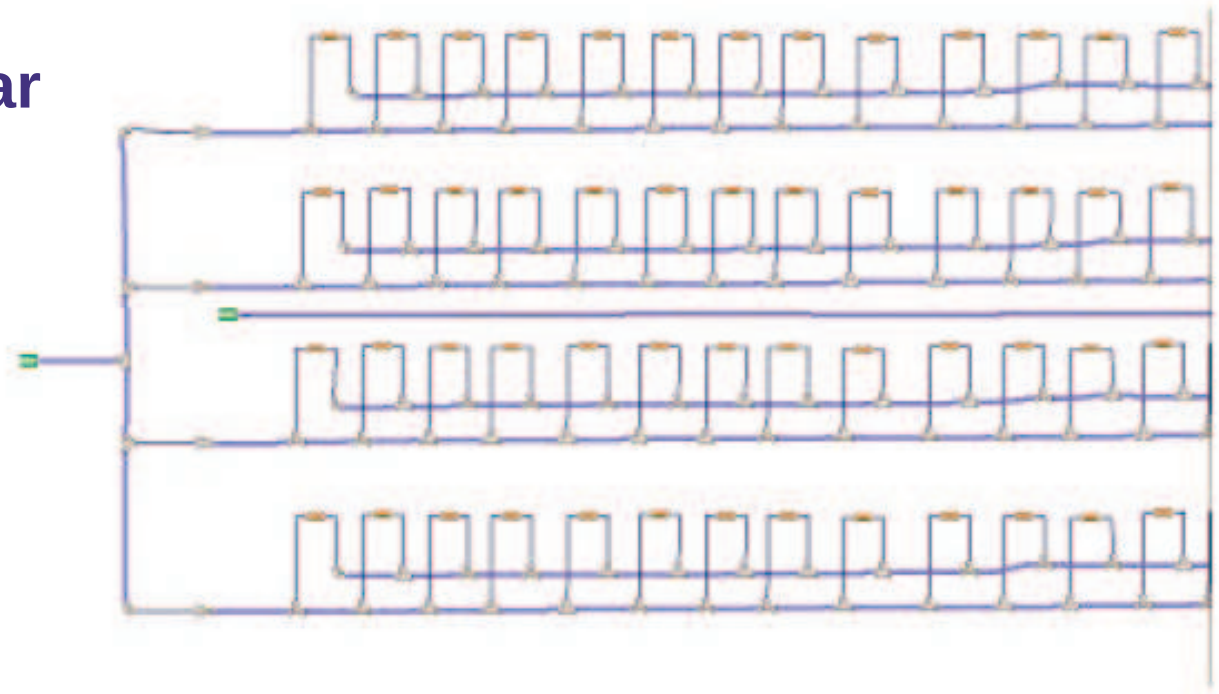


Figure 8. A Section of the Complete System

Loop Volume

Using 1” dia manifolds, pipes, and 25k ton dimensions,

Single loop water volume = 2960 cu in
= 12.8 gal
= 107 lb

Weight of water system, guess at 2x this, ~200lbs
Total length of system is ~100 feet, so 2lbs/ft, 24lbs/span
But, it’s just plastic, so we will need several supports along the span, probably every 3-4ft.

Total water volume, 144 loops, = 1843 gal
= 15400 lb

Old Loop Cost Estimate

SWAG cost estimate for loops on detector top, side loops a bit lower:

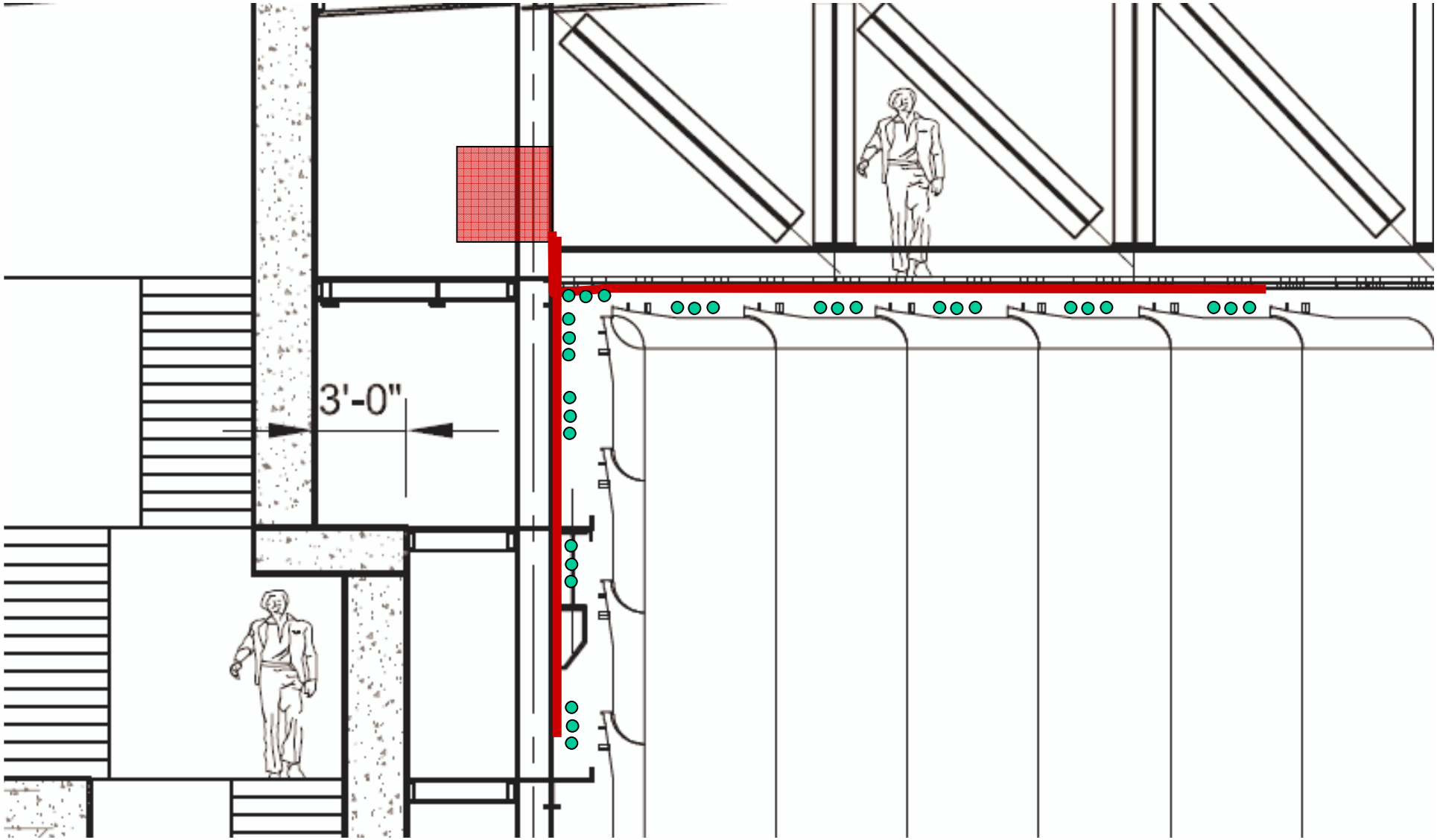
1	Pump 1/25hp bronze cast	$ 150	$ 150
1	Heat Exchanger (~LytronLL520)	$ 200	$ 200
16	Top manifold assembly	$ 830	$ 13280
1	Fluid Reservoir	$ 50	$ 50
1	Fluid level switch(float, capacitive, other)	$ 80	$ 80
2	Temp probes, RTD in welded SS fitting	$ 50	$ 100
1	Flow switch (~Omega FST-211-SPST)	$ 160	$ 160
1	enclosure	$ 200	$ 200
6	Remote I/O channels(2 temp, 1flow, 1 level, 1 pump status, 1 pump control)	$ 200	$ 1200
x	Misc pipe, wire, cable	$ 100	$ 100
24	man-hours assembly: mount 8 manifold sections make 512 quick connects mount & connect pump & other components install wire duct, field wiring, fill, test etc.	$ 50	$ 1200
	Total		$ 16720

New Loop Cost Estimate

SWAG cost estimate for loops on detector top, side loops a bit lower:

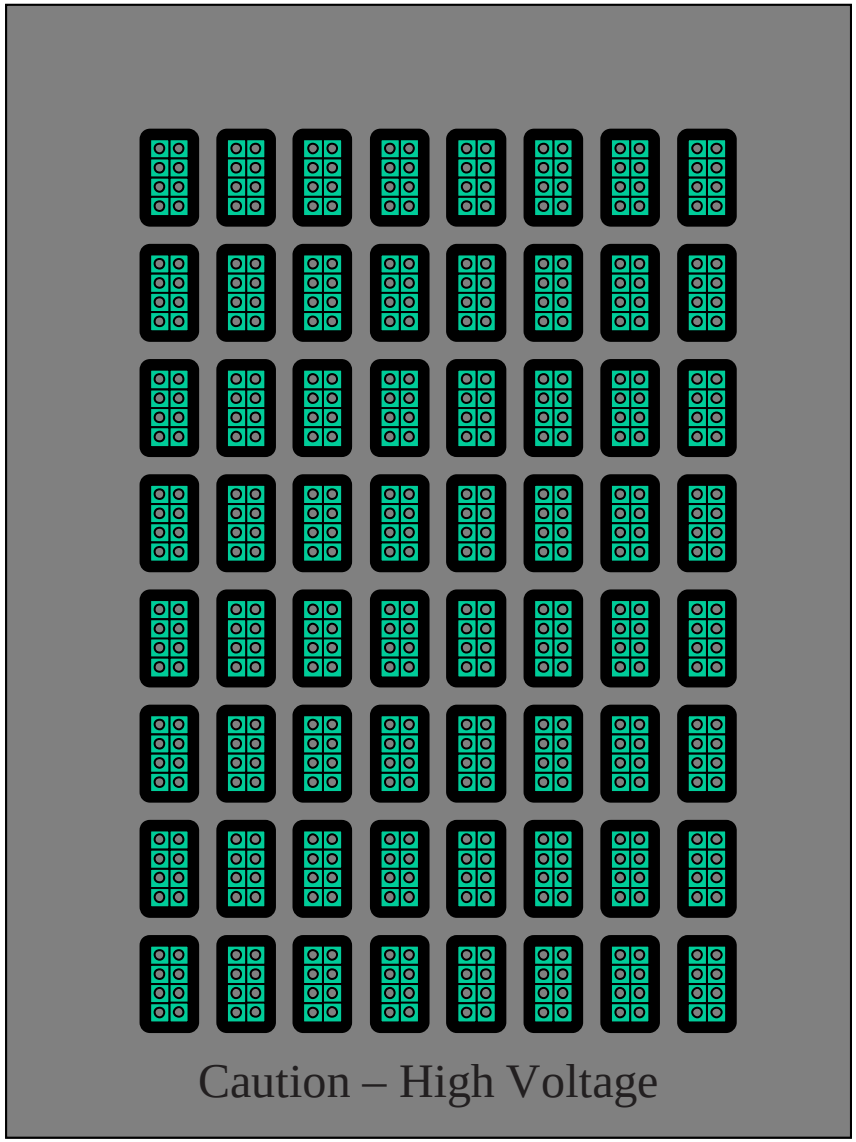
1	Pump 1/6 hp bronze cast	$ 300	$ 300
1	Heat Exchanger (~LytronLL520)	$ 200	$ 200
14	Top manifold assembly	$ 780	$ 10920
1	Fluid Reservoir	$ 50	$ 50
1	Fluid level switch(float, capacitive, other)	$ 80	$ 80
2	Temp probes, RTD in welded SS fitting	$ 50	$ 100
1	Flow switch (~Omega FST-211-SPST)	$ 160	$ 160
1	enclosure	$ 200	$ 200
6	Remote I/O channels(2 temp, 1flow, 1 level, 1 pump status, 1 pump control)	$ 200	$ 1200
x	Misc pipe, wire, cable	$ 100	$ 100
24	man-hours assembly: mount 8 manifold sections make 512 quick connects mount & connect pump & other components install wire duct, field wiring, fill, test etc.	$ 50	$ 1200
	Total		$ 14510

Utilities Version A



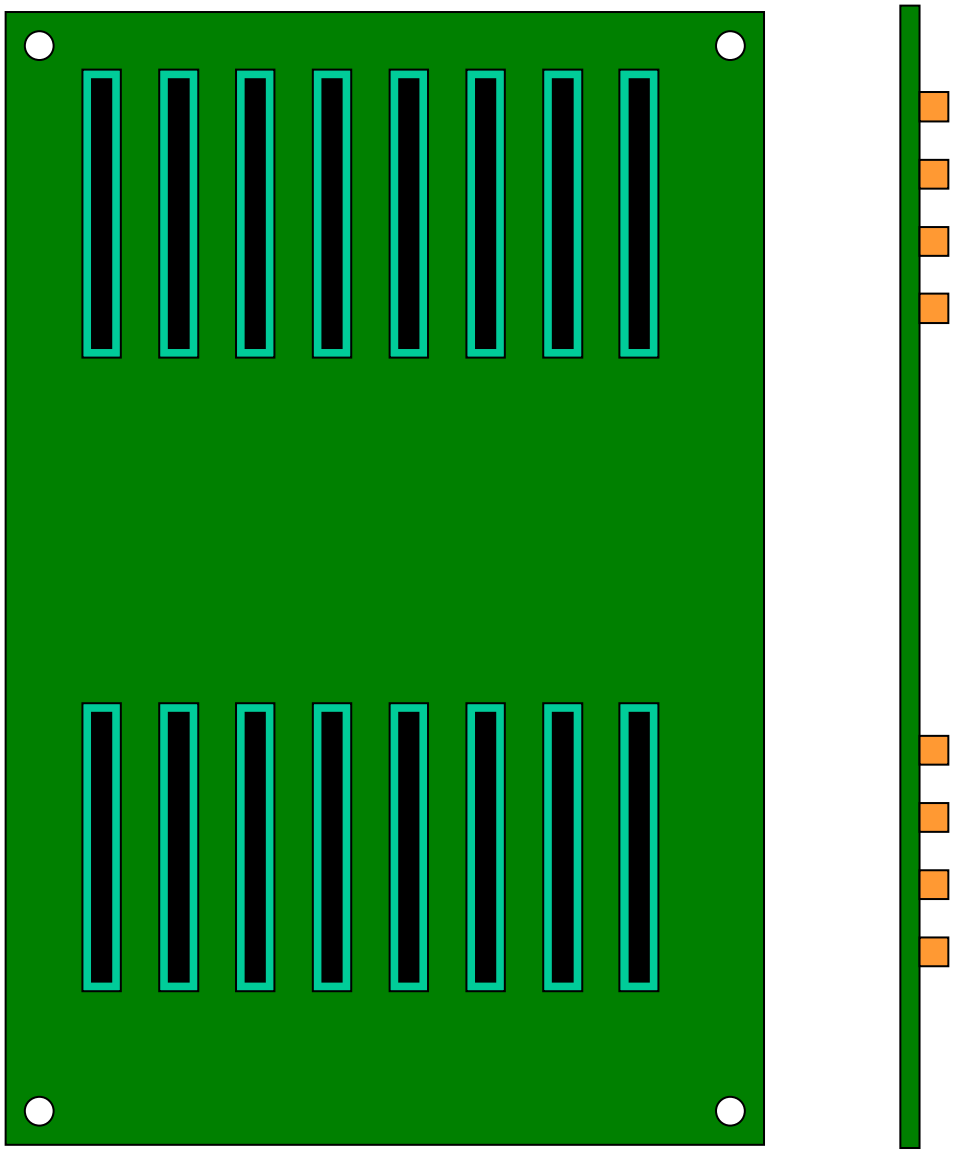
Distribution Box

- Completed Distribution Box
- Card Cage not shown
- Power Dist Boxes
  - $362k



Power Backplane

- Backplane with Cu bus bars



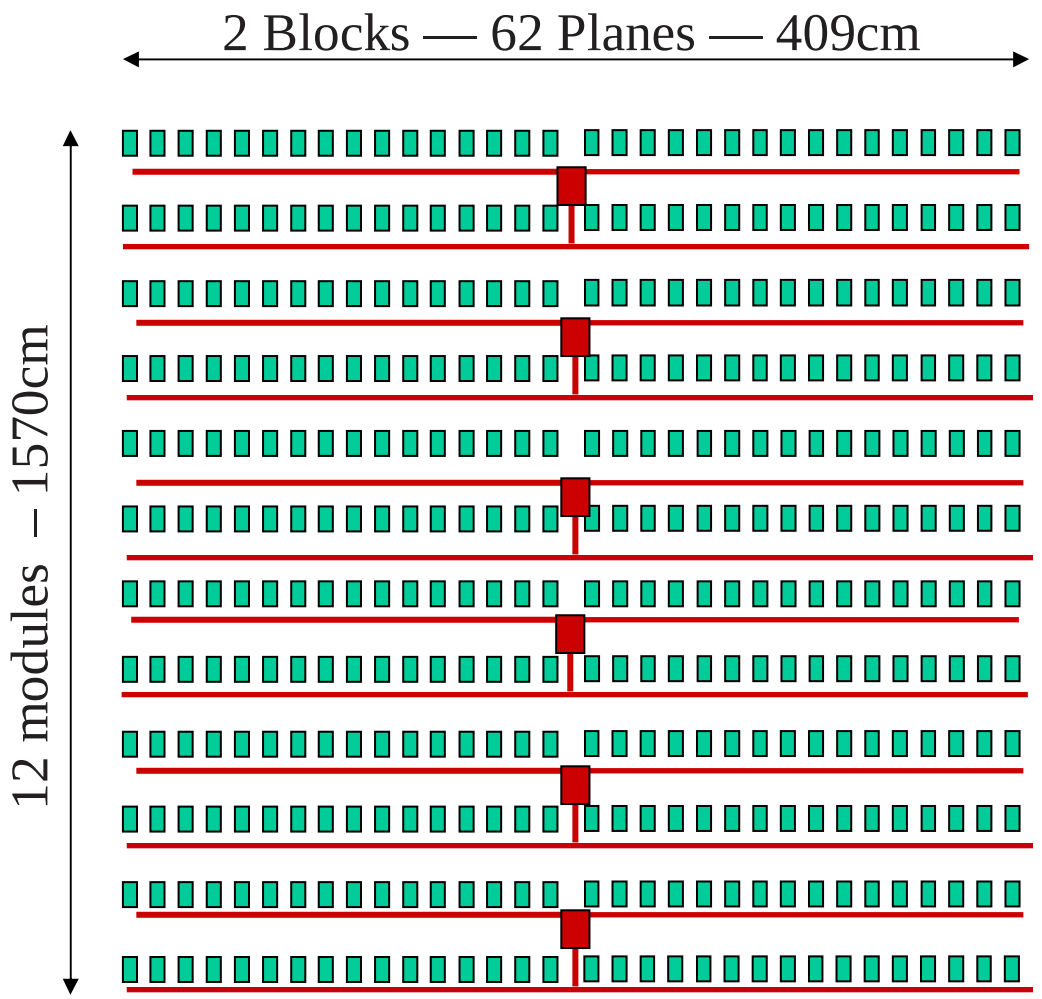
Top Power/Data

High Voltage
Low Voltage
Local redistribution
(1.7m avg. cable length)

Each Power Distribution Box powers 64 boxes

DAQ services along same route from neighbor box

~2”x6” Cable Tray along Detector



Power Distribution Box

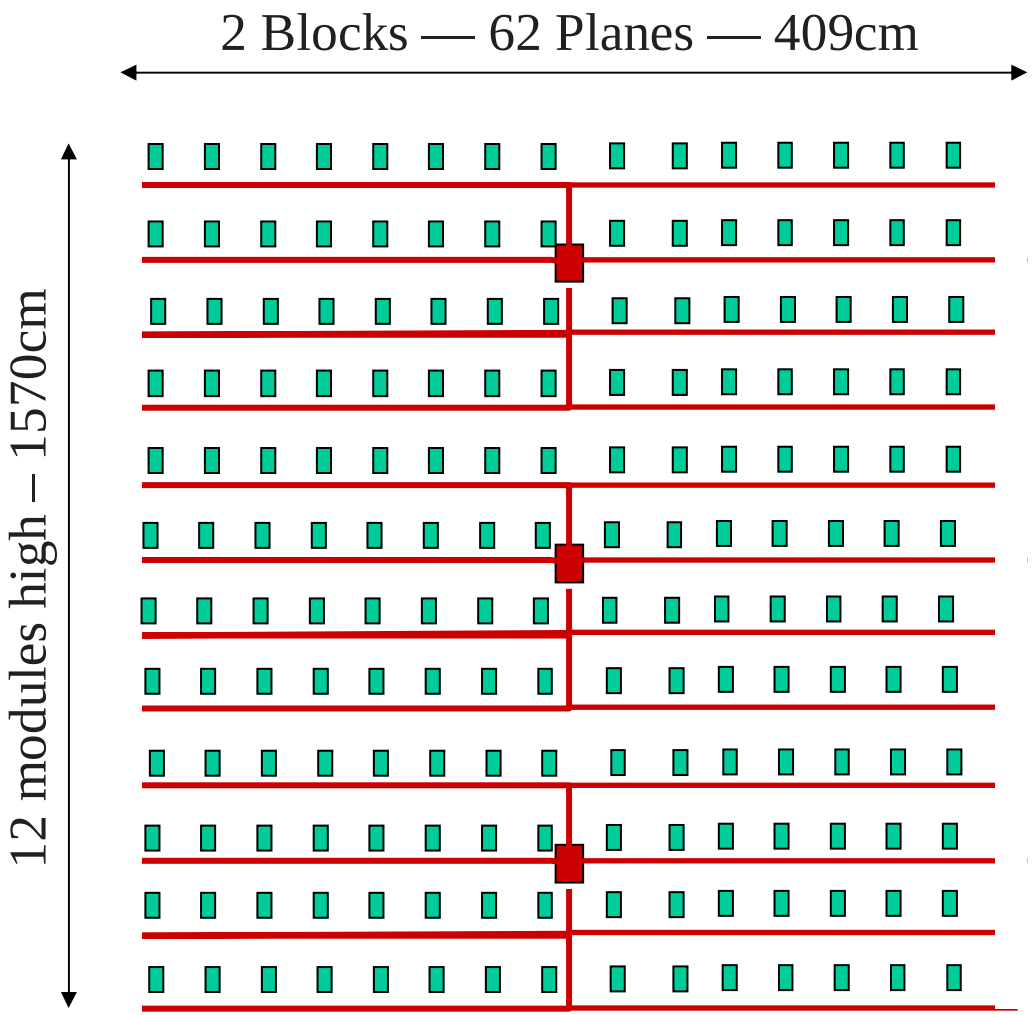
APD readout box

Side Power/Data

High Voltage
Low Voltage
Local redistribution
(2.3m avg. cable length)

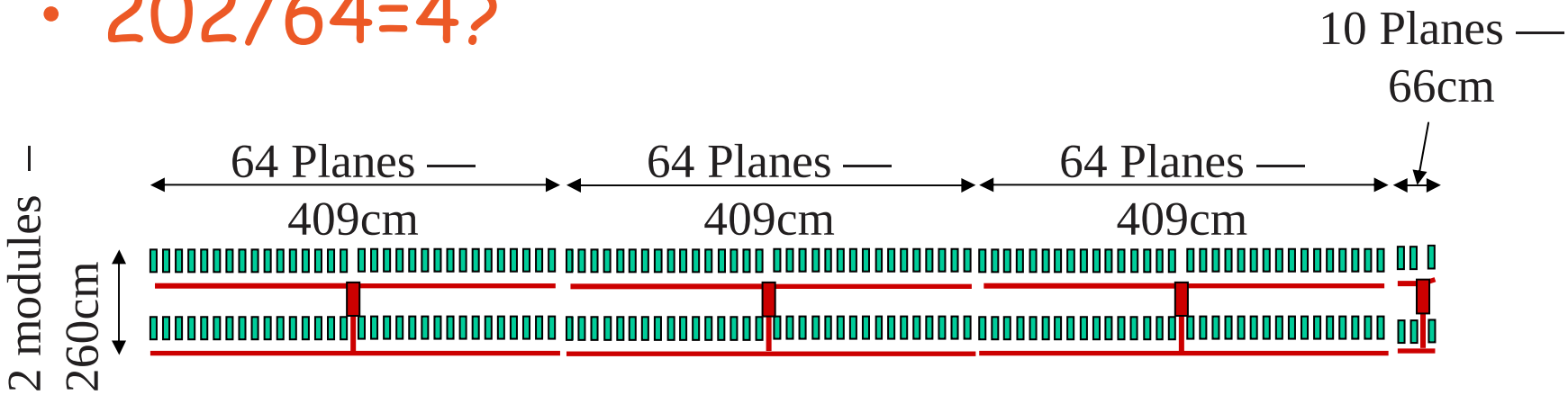
Each Power Distribution Box powers 60 boxes

DAQ services along same route



IPND Top Power

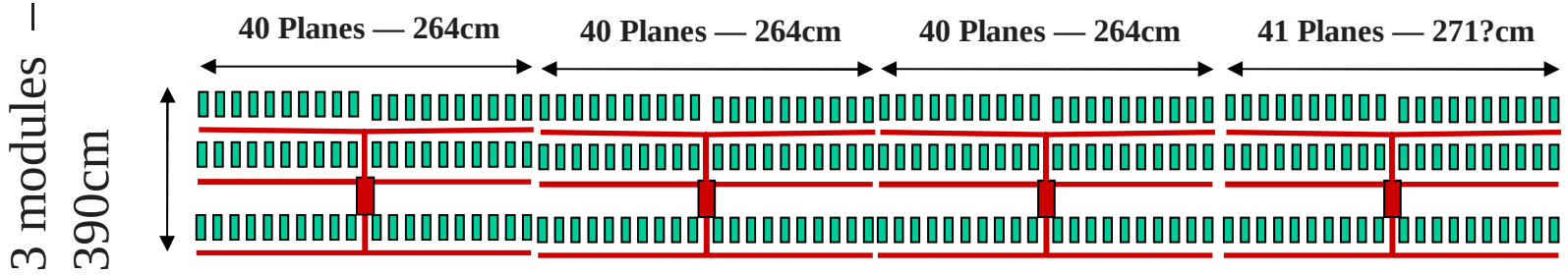
- Distribution to 202 modules
- 202/64=4?



- Can we drop 10 planes?
- Better Distribution with 50/50/50/52
  - Special channel map for DAQ

IPND Side Power

- Distribution to 303 modules
- 303/64=5?
- 60/60/60/63



Cable loading weights

- Largest weight of cables
  - DAQ 0.8lb/ft
  - Power 1.5lb/ft
  - TOTAL 2.3lbs/ft
- Cable tray weight
  - 1.4lb/ft (for 2x12 wire mesh)
  - Tray capacity 8.3lbs/ft
- Hang H20 from cable trays?

Comments/Questions

- Nothing here about readout box mounting
  - Will be working with Tom Chase to define mounts, box and mounting procedures
  - PLAN for box to fit within the plane of the module, avoiding interference issues
- How much space between detector and steel
- How much space around IPND/ND in ALL dimensions, top, side, front, back